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16. ABSTRACT
The potential hazard to workers exposed to the organophosphorus pesticide, parathion, in formulating plants was studied. Potential dermal and respiratory exposure near certain work stations was determined. Calculations were based on the use of minimum protection (no respirator, shirt with short sleeves and open collar, no hat, no gloves, and with the assumption that the clothing worn gave complete protection of body areas covered). This was to arrive at values that might reflect the maximum potential exposure that could occur in different work situations where proper protective gear was not utilized. Mean dermal exposure for all workers was 67.3 mg/hr and the mean respiratory value was 0.62 mg/hr of work activity. Workers at the bagging machine were subjected to greater exposure than mixers or workers who stacked filled bags on pallets, operated the bag closing machine, or packed filled bags in cardboard cartons for storage or shipment. Considerable variation was found in the range of exposure values for each work activity. Such variations were thought to be due to several factors, including worker carelessness and bagging equipment malfunction. The results indicated that workers in formulating plants exposed under conditions similar to those found in the study should not become lax in the use of approved protective gear on in following other safety precautions that prevent excess exposure to highly toxic pesticides. Relatively high values obtained during a few of the tests exposure periods indicated that even minor lapses in adherence to safety precautions might be sufficient to allow poisoning to occur.

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Exposure of Pesticide Formulating Plant Workers to Parathion

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Parathion (O,O-diethyl O-p-nitrophenyl phosphorothioate), one of the most widely used highly toxic organophosphorus insecticides, has received considerable attention in past years as far as potential hazard to workers is concerned. Several studies have been conducted to determine amount of absorption of this compound by applicators in the field and workers in pesticide formulating plants (SUMERFORD et al., 1953; HAYES et al., 1957; ARTERBERRY et al., 1961; WOLFE et al., 1970; DURHAM et al., 1972). These exposure studies were based primarily on measurement of blood cholinesterase level, urinary p-nitrophenol excretion, or poisoning symptoms. Another type of exposure study designed to provide information useful in calculating the amount of pesticide that impinges on exposed skin areas or is available for entry into the body via the respiratory route has been carried out on pesticide applicators (WOLFE et al., 1967) but not on workers exposed to parathion in formulating plants. The purpose of the present study was to bridge this information gap by obtaining data on potential dermal and respiratory exposure of workers to that pesticide during formulation activities.

MATERIALS AND METHODS

Exposure studies were conducted in two plants formulating 25% water-wettable powder parathion. These plants were chosen as somewhat typical of formulating plant operations in the Pacific Northwest--an area where serious illness due to occupational exposure in such plants has been rare. In order to determine the potential exposure in different work situations, exposure pad studies were carried out on (1) workers who inserted the proper proportions of ingredients into the formulating machine (mixers), (2) workers who filled bags with the formulated pesticide at the filler spout (baggers), (3) workers who worked alternately at the mixing and bagging stations (mixers-baggers), and (4) workers who stacked full bags on storage pallets, operated the machine for closing bag tops, or packed bags in cartons for shipment (stackers-sealers-carton packers). Exposure tests were carried out during work periods lasting from 30 minutes to 1 hour.

The amount of parathion to which a worker potentially would be subjected during work activities was estimated by the techniques and procedures described by DURHAM and WOLFE (1962).

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Dermal contamination was measured primarily by attaching layered-gauze absorbent pads to various parts of the worker's body or clothing and allowing them to be exposed during a timed period of work. Respiratory exposure was estimated from the contamination of special filter pads used in place of the usual outer absorbent filter pads which cover the filter cartridges of the respirators worn by the subjects. The filter pads were covered with plastic funnels modified to a specific aperture size to reproduce as nearly as possible the aerodynamics of air flow through nostrils. The funnels also prevented direct impingement of particles onto the pad except for those carried through the apertures by respiratory action. This technique renders it unnecessary to measure total air volume because all inhaled air passes through the filter pads.

Potential exposure calculations were based on the use of minimum protection (no respirator, shirt with short sleeves and open collar, no hat, no gloves, and with the assumption that the clothing worn gave complete protection of body areas covered). This was to arrive at values that might reflect the maximum potential exposure that could occur in different work situations where proper protective gear was not utilized. Values obtained were used to calculate the milligrams of potential exposure per man per hour of work activity. The percent of the toxic dose to which workers were potentially exposed was calculated by the procedure described by DURHAM and WOLFE (1962), based on comparison between the dermal and respiratory exposure values determined in the present study and animal toxicity figures published by GAINES (1969).

Respirator and dermal exposure pads were extracted with benzene in a Soxhlet apparatus and analyzed for parathion by electron-capture gas liquid chromatography.

RESULTS AND COMMENT

As can be seen in Table 1, mean dermal exposure for all workers was 67.3 mg/hr and the mean respiratory value was 0.62 mg/hr of work activity. Workers at the bagging machine were subjected to greater exposure than mixers or workers who stacked filled bags on pallets, operated the bag closing machine, or packed filled bags in cardboard cartons for storage or shipment. It is interesting to note that the highest exposure values obtained were for workers who alternated between bagging and mixing. We were unable to determine the reason why potential exposure of such workers was higher than for those who worked continually at either of the work stations. Considerable variation was found in the range of exposure values for each work activity. This was expected, based on our earlier research in formulating plants during mixing of carbaryl (COMER *et al.*, 1975) and DDT (WOLFE and ARMSTRONG, 1971). Such variations may be due to several factors, including worker carelessness and bagging equipment malfunction.

TABLE 1

Potential Dermal and Respiratory Exposure of Workers to Parathion in Pesticide Formulating Plants

Subject	No. of exposure periods tested	Calculated exposure (mg/hr of work activity)[a]	
		Dermal	Respiratory
All workers	57	67.3 ± 88.8	0.62 ± 0.08
Mixers	8	38.4 ± 37.5	0.55 ± 0.48
Baggers	17	82.1 ± 98.4	0.69 ± 0.77
Mixers-baggers	7	183.7 ± 92.7	0.93 ± 0.51
Stackers-bag sealers-carton packers	25	34.0 ± 62.0	0.50 ± 0.62

[a] Mean ± S.D. Exposure values calculated on the basis of no respirator, shirt with short sleeves and open collar, no gloves or hat, and with the assumption that the clothing worn gave complete protection of the areas covered.

Using mean dermal and respiratory values for all workers as noted above, the calculated fraction of a toxic dose received would be 5% per hour of exposure. However, if all the parathion indicated by the highest dermal and respiratory values obtained during an individual test period (335.3 mg/hr dermal and 3.38 mg/hr respiratory for bagger) were to be completely absorbed by a worker, he would be subjected to approximately 25% of a toxic dose per hour of exposure, based on minimum protection as described earlier. These values indicate that very high exposure conditions can occur. Apparently, not all of the parathion that impinges on exposed skin areas is absorbed, otherwise the hazard would be much greater, with the occurrence of more illnesses than have been reported during past years. Fortunately, practically all workers in formulating plants wear required protective gear, especially when working with highly toxic compounds. This apparently reduces potential dermal and respiratory exposure considerably.

As expected, potential exposure to parathion was found to be higher for formulating plant workers than for spraymen; e.g., the mean value for potential dermal and respiratory exposure of workers applying parathion in orchards by air blast machine was found to be 19 and 0.02 mg/hr of work, respectively (WOLFE

et al., 1967), as compared with the 67.3 and 0.62 mg/hr found in the present study for formulating plant workers.

The above results indicate that workers in formulating plants exposed under conditions similar to those found in the present study should not become lax in the use of approved protective gear or in following other safety precautions that prevent excess exposure to highly toxic pesticides. The relatively high values obtained during a few of the test exposure periods indicate that even minor lapses in adherence to safety precautions might be sufficient to allow poisoning to occur.

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